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METHOD AND DEVICE FOR REGULATING THE TEMPERATURE OF A COOLANT OF AN INTERNAL COMBUSTION ENGINE

Background Information

The present invention relates to a method for regulating the temperature of a coolant of an internal combustion engine, a temperature sensor detecting the temperature of the coolant and a first control unit controlling and/or regulating the coolant temperature in order to obtain a predetermined temperature setpoint value, a further control unit being provided whose signals are fed to the first control unit, the further control unit relaying signals about an established driver type of the motor vehicle to the first control unit and, depending on whether the driver type is classified as economical or sporty, the first control unit presetting the temperature setpoint value.

Furthermore, the method relates to a device, in particular for a motor vehicle having an internal combustion engine and a cooling device, including a control unit for controlling and/or regulating a setpoint temperature value of a coolant, and a temperature sensor for measuring the actual temperature value, and a valve for setting a coolant volume flow to a radiator and/or to the internal combustion engine, a second control unit being provided which works together with the first control unit in order to relay information in regard to the driver type, specifically a sporty or economical driver type, to the first control unit and, on the basis of this information, a temperature setpoint value being determinable by the first control unit.

A device of this type and a method of this type are known, for example, from DE 199 51 362 A1, which discloses a method for

regulating the cooling water temperature, a temperature sensor detecting the cooling water temperature and a control unit for the cooling water temperature actuating at least one valve and/or one fan in order to obtain a predetermined temperature setpoint value of the cooling water, a further sensor and/or an engine or vehicle control unit being provided whose signals are fed to the first control unit, the first control unit determining a temperature setpoint value therefrom. The determination of the setpoint value may be predetermined in this case as a function of the driver type, a driver who drives sportily or economically, for example.

In this way, the exhaust gas value and the fuel consumption are to be optimized and/or minimized.

Furthermore, regulating the temperature of an internal combustion engine in such a way that different temperature setpoint value ranges are used for the temperature regulation on the basis of different operating conditions is known from DE 41 09 498 A1, for example. In particular, operating parameters of the internal combustion engine, among other things switching on of auxiliary systems and malfunctions of the internal combustion engine, may be cited as operating conditions. The setpoint value of the cooling water temperature is set depending on which priority the different operating conditions have.

It is thus the object of the present invention to specify a method and a device for regulating the temperature of an internal combustion engine through which it is possible to reduce the fuel consumption further, in particular for the economical driver, without performance losses being noticeable for the sporty driver and to reduce the emissions overall.

This object is achieved by the present invention through a method in which the volume flow of the coolant for cooling the

internal combustion engine is regulated and/or controlled by the control unit as a function of the driver type established.

Alternatively, the object is achieved by a corresponding device.

It is known that the efficiency of an internal combustion engine cooled using a coolant may be increased in the part-load range if the temperature of this coolant is elevated above the currently mostly set value of 95° Celsius, to a range of 105° - 115° Celsius. In the full-load range, however, the temperature of the coolant must be lowered again in order to limit damage to the internal combustion engine and/or performance losses. The present method thus opens up further possibilities for temperature regulation of the engine using higher temperatures in part-load operation and lower temperatures in full-load operation, using which the problem of knocking and/or performance losses in the transition from part-load to full-load operation may be minimized.

It is thus advantageous to include the driver type in the operating parameters which the method uses for control, the typical algorithms for determining a driver type to be used in this case, according to which a sporty driver type is determined if frequent and rapid load changes are performed and an economical driver type is concluded in the event of infrequent and slow load changes.

If the quantity of the coolant that flows to the internal combustion engine, i.e., the coolant volume flow, is also made a function of the driver type, the danger of local overheating at especially hot points of the cylinder head, which may arise in the event of a strong and sudden elevation of the engine load, for example, may also be avoided still.

In this case, for example, the method assigns a relatively low coolant volume flow to an economical driver type, in

particular in part-load operation. Thus, little energy is necessary for circulating the coolant and the desired temperature is achieved more rapidly even in the warmup phase of the engine. Both parameters have a favorable effect on the fuel consumption.

If a rapid and strong load elevation nonetheless occurs, a higher coolant volume flow must first be achieved before the coolant may dissipate the waste heat of the engine, which is now strongly increased. Therefore, if it is to be expected that rapid and strong load elevations will occur, since the driver type is rather sporty, the method initially assigns this driver type a higher coolant volume flow than an economical driver type (even in part-load operation). Therefore, in case of a rapid and strong load elevation, a volume flow sufficient to reliably dissipate the waste heat is immediately available. A higher coolant volume flow of this type and therefore also an elevated fuel consumption is more acceptable for a sporty driver.

Furthermore, the coolant temperature may be controlled and/or regulated between an upper and a lower limiting value by the control unit. In particular, 95° Celsius, which has been typical until now, may be used as the lower limiting value, and a value between 105 and 115° Celsius may be used as the upper limiting value.

In this case, it may be provided that temperatures outside these temperature limits are not approached.

For the determination of the driver type, only a selection between an economical and a sporty driver type may be provided; however, intermediate values may also be fixed, these values being determinable continuously or in discrete steps. Intermediate values may then also be set between the two limiting values previously cited in this case. For this purpose, a digital selector switch merely between "sporty" and

"economical" may thus be provided; however, the selector switch may also approach multiple intermediate steps.

According to a first exemplary embodiment, the coolant temperature may lie closer to the upper limiting value the more the driver type is classified as the economical driver type. In this case, in particular in part-load operation, a higher cooling water temperature may be set for the economical driver type than for the sporty driver type. For intermediate values, the coolant temperature may be set lower the closer this intermediate value is to the sporty driver type. The method is especially advantageous when it is implemented for part-load. The method according to the present invention may thus assign a lower coolant temperature setpoint value to a sporty driver type than to an economical driver type, even for part-load operation of the engine. The coolant temperature will thus be closer to the lower limiting value, in particular in part-load operation, the more the driver type is classified as the sporty driver type. In this way, for a sporty driver type, the danger of performance loss upon changing from part-load operation to full-load operation is lower, even if this is at the price of elevated fuel consumption. Because of the elevated coolant temperature in part-load operation, the economical driver type achieves lower fuel consumption, which is, however, connected with a higher risk of performance loss in the transition from part-load operation to full-load operation. In this case, even for the economical driver type, a shift in the direction of the upper limiting value may only be provided when the internal combustion engine is operated in part-load operation.

In particular, for the sporty driver type, no shift in the direction of the upper limiting value may occur, even for part-load operation of the internal combustion engine. It appears more acceptable for a sporty driver type to tolerate this lower cooling water temperature and therefore the elevated fuel consumption, instead of the performance loss.

In particular, in the method according to the present invention it may be provided that the sporty driver is assigned a higher coolant flow, at least in part-load operation, than the economical driver type. Because of this assignment, the danger of local overheating at especially hot points in the cylinder head, as may otherwise arise in the event of a strong and rapid increase of the engine load, is reduced for a sporty driver. However, an elevated fuel consumption is achieved, since more coolant must be circulated.

The economical driver type may be assigned a lower coolant volume flow only in part-load operation, and the coolant flow for the sporty and the economical drivers may be identical in full-load operation.

In particular, there may be no adaptation of the coolant volume flow for the sporty driver type even in part-load operation, i.e., the coolant volume flow for the sporty driver may always be equally high.

In this way, performance losses and the danger of overheating of the engine may be prevented even better.

In addition, the present invention relates to a control unit of an internal combustion engine, in particular for a motor vehicle, on which a program is stored, which is executable on a computing device, in particular a microprocessor, and is capable of executing a method as described above.

Furthermore, the present invention relates to the device already described for a motor vehicle having an internal combustion engine, whereby the internal combustion engine in particular may include a control and/or regulating unit as was described above.

The control unit which is used as the second control unit may be the electronic engine control unit in particular.

Further advantages and features of the present invention result from the remaining documents of the application. The features may be essential for the present invention individually or in any arbitrary combination with one another.

In the following, the present invention is to be described in greater detail on the basis of an exemplary embodiment. The exemplary embodiment is illustrated in the drawing.

Figure 1 shows a schematic circuit diagram of a cooling circuit of an internal combustion engine.

In this case, the internal combustion engine includes an internal combustion engine 10 and a coolant pump 12, which may pump the coolant through a cooling circuit for cooling internal combustion engine 10. In this case, coolant pump 12 may either be driven directly by the crankshaft of internal combustion engine 10 via a belt or it may be an electrically driven coolant pump.

Coolant pump 12 is connected to a device for varying coolant volume flow 14 in this case. In particular if coolant pump 12 is an electrical coolant pump, the variation of the volume flow is especially simple to perform.

Via a coolant line 16, either all or part of the coolant may flow via a radiator 18 and thus be cooled.

Via a thermostat valve 20 and a bypass line 22 it may be achieved that coolant is able to flow past radiator 18. A bypass line 22 of this type may optionally be provided.

Via a further coolant line 24, coolant from internal combustion engine 10 is conducted from the internal combustion

engine via a heater heat exchanger 26 to coolant pump 12. A passenger compartment may be heated via heater heat exchanger 26, for example.

In this case, thermostat valve 20 may be actuated by an electronic first control unit 30 via an actuator 28. Depending on the position of valve 20, a larger or smaller part of the coolant volume flow flows via radiator 18 and is cooled. By mixing coolant which was cooled via the radiator and coolant which flows via bypass line 22 and/or heater heat exchanger 26, the temperature of the coolant at the intake of internal combustion engine 10 may be set by electronic control unit 30.

In addition, at least one temperature sensor 32 is provided in the cooling circuit, via which control unit 30 may determine the temperature of the coolant, i.e., the actual temperature.

In addition, a second electronic control unit 34 is provided, which may be the engine control unit in particular in this case. This second control unit 34 determines a driver type in the range between economical and sporty from a method known according to the related art (in particular for transmission control). In this case, a finite number of intermediate values, which may also be set, may be provided between these two values. Control unit 34 analyzes the position of a selector switch (not shown) for this purpose.

Second electronic control unit 34 has a data link to first electronic control unit 30, via a CAN bus, for example, in this case.

Alternatively, the first and the second control unit may also be implemented in one single control unit.

In order to reduce the fuel consumption, improve the emissions, and nonetheless obtain a satisfactory performance distribution, and to reduce the tendency to knock in

particular, it is now provided to influence the coolant temperature depending on whether the driver is sporty or economical.

For this purpose, a corresponding control program for performing a method according to the present invention is stored in control unit 30. Through the method, valve 20 is opened and closed via actuator 28. By changing the position of valve 20, the temperature of the coolant may be varied, since the flow of the coolant which flows via radiator 18 is varied in this way. In this case, besides the other operating parameters of the internal combustion engine, the control program also takes the driver type determined in control unit 34 into consideration in particular. The control program in control unit 30 actuates valve 20 via actuator 28 in this case in such a way that, at least for some values of the operating parameters of the internal combustion engine, a different, in particular a lower value of the coolant temperature is set for a sporty driver type than for an economical driver type. If there is an intermediate value of the driver type between "sporty" and "economical," the coolant temperature may be set lower for this intermediate value of the driver type the closer this intermediate value is to the driver type "sporty."

In particular, a lower value of the coolant temperature is set for a sporty driver than for an economical driver for the operating parameter "part-load" of the internal combustion engine. For intermediate values, the statement above applies. In particular, it may be provided that for a sporty driver, also for part-load operation, no higher value of the coolant temperature is set than is the case for full-load, while for an economical driver type a higher value of the coolant temperature is set for part-load than is the case for full-load. Thus, for example, for an economical driver type, the temperature in part-load operation may be raised to 105° - 115° Celsius as the upper limiting value and the coolant temperature may only be reduced to 95° Celsius in full-load

operation in order to limit damage to the internal combustion engine and/or performance losses. However, the efficiency of internal combustion engine 10 may be increased by increasing the coolant temperature.

In addition, according to the present invention, besides varying the coolant temperature as a function of the driver type, the volume flow of the coolant is also varied by control unit 30 via device 14 as a function of the driver type. In this case, the control program in control unit 30 assigns a relatively low coolant volume flow to an economical driver type, in particular in part-load operation. Thus, little energy is necessary for circulating the coolant and the engine reaches the desired temperature more rapidly in the warmup phase. A lower fuel consumption is thus achieved.

In case of rapid and strong load elevation, however, a higher coolant volume flow must first be achieved before the coolant may dissipate the waste heat of the engine, which is now strongly increased. Therefore, the control program in control unit 30 assigns a higher coolant volume flow to a sporty driver, in particular in part-load operation, than to an economical driver type. In this way, a sufficient coolant flow to ensure heat dissipation reliably and prevent damage to internal combustion engine 10 is always available for a sporty driver type. Since a sporty driver type is usually distinguished by frequent and rapid load changes, the elevated coolant volume flow of this type is appropriate. The elevated fuel consumption connected therewith is accepted. In particular, for the sporty driver, even for part-load, a lower value of the coolant quantity than is the case for full-load may not be set.

For intermediate values of the driver type which lie between "sporty" and "economical," the volume flow is set lower for identical load the closer the driver type lies to economical.

The driver type is determined in a known way, in particular in that a sporty driver type is concluded in the event of frequent and rapid load changes and an economical driver type is concluded in the event of infrequent and slow load changes.